63-3-4

7486 CERAMIC TRIODE

PRODUCTION ENGINEERING MEASURE

THIRD QUARTERLY PROGRESS REPORT

1 JANUARY 1963 THROUGH 1 MARCH 1963

CONTRACT NO. DA-36-039-SC-86738

U. S. ARMY ELECTRONICS MATERIEL AGENCY

PHILADELPHIA, PENNSYLVANIA

CLASSIFICATION - NONE

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

OWENSBORO, KENTUCKY

7486 CERAMIC TRIODE, PRODUCTION ENGINEERING MEASURE

THIRD QUARTERLY PROGRESS REPORT

1 JANUARY 1963 THROUGH 31 MARCH 1963

Objective: (1) To provide improved vacuum exhaust equipment for processing 7486 tubes.

(2) To improve tube ratings by evaluation on new test equipment.

(3) To increase tube life expectancy by improved tube design features.

(4) To demonstrate 100 tube per day production capability.

(5) To prepare and distribute progress reports.

(6) To prepare the Step II report covering a rate of 10,000 tubes per month.

CONTRACT NO. DA-36-039-SC-86738

SIGNAL CORPS INDUSTRIAL PREPAREDNESS
PROCUREMENT REQUIREMENTS NO. 15

CLASSIFICATION - NONE

REPORT BY - J. D. MARSHALL

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1.0 ABSTRACT

The expected delivery of the vacuum system has been delayed. Life testing has been completed for evaluation of the present product. Testing of heater design changes has been completed. Effects of new cathode spray masks have been evaluated. Construction of tubes containing design changes was started and life testing will soon begin.

2.0 PURPOSE

One of the objectives of this contract is to provide improved tube processing equipment capable of producing 100 tubes type 7486 per day. The principal improvement in processing will be to fire component parts and seal tubes on ion pump exhaust equipment. Other improvements in cathode spray equipment and assembly jigs and fixtures are expected to improve the uniformity of the product. By evaluation under various conditions on new test equipment it is intended to reflect the benefits of this work in improved ratings of this tube, particularly in the areas of high frequency performance, and to give assurance that these ratings will be compatible with stable performance during life.

This evaluation includes life testing at increased values of plate dissipation and cathode current, under 450 megacycle conditions. Performance tests will also be conducted at 2200 and 5900 megacycles.

Design modifications will be made to the heater to assure longer life. The advantages of tungsten-rhenium wire and darkened insulation coating will be demonstrated.

The test requirements for the improved tube are defined by the SCL-7001/74 specification dated 24 May 1962.

3.0 NARRATIVE AND DATA

3.1 TASK I - VACUUM EXHAUST EQUIPMENT

The vacuum system has not been delivered. It was to have been ready for inspection by General Electric at Palo Alto by March 15, 1963. Delivery in Owensboro was expected by March 29, 1963. The delay was reported to be due to a relocation to new facilities by the supplier. Delivery is now expected late in April.

Installation and prove-out is still planned at the site of final operation.

3.2 TASK II - TEST EQUIPMENT

Life testing of the present product on the new test equipment has been completed.

3.2.1 - 450 MC LIFE TEST

A 50 tube sample was tested at 450 Mc. Ten tubes were subjected to each of the five test conditions as reported in the Second Quarterly Report (3.2.1,page 4). Table I repeats those conditions here for convenience.

Condition	Eb (Volts)	Ip (ma)	Ig (ma)	P(in) (Watts)	Po (Watts)
1	150	7	3	1.25	0.6
2	150	10	5	1.5	0.85
3	200	15	7	3.0	1.8
4	250	15	6	3.75	2.3
5	350	20	8	7.	4.2

Table I 450 Mc Life Test Conditions

The inoperative failure rate on the 50 tubes tested was 4% and these were identified as grid to plate shorts. These may have been due to loose particles within the tube. They do not appear to be related to the test conditions.

One failure occurred for a change in frequency beyond the life test end point limit of 50 Mc.

The values of power output measured at 5900 Mc were compared to the specified life test end point of 3 mW and also to a 15 mW minimum. A failure rate of 6% occurred when comparing to the 3 mW end point, and a 12% failure rate is reported when comparing to the 15 mW minimum. One half of the total failures occurred in the sample tested at condition 5.

A comparison was also made of readings for zero bias transconductance. Condition 2 (Ik = 15 mA) was the most stable while condition 5 (Ik = 28 mA) showed a 10% degradation. Figure 1 shows a graphical representation of the results of this test. The average percentages of change in zero bias transconductance by conditions are:

Condition 1	-2.0%
Condition 2	0%
Condition 3	-7.1%
Condition 4	-2.35%
Condition 5	-10.4%

Zero bias transconductance is not a life test end point condition for 450 Mc life, but it was included for information as a point

RTD-363-G (10-56) rev.
(100X140-B)

ELECTRONIC COMPONENTS DIVISION

GENERAL ELECTRIC

TYPE - 7486

60 CYCLE LIFE TESTS

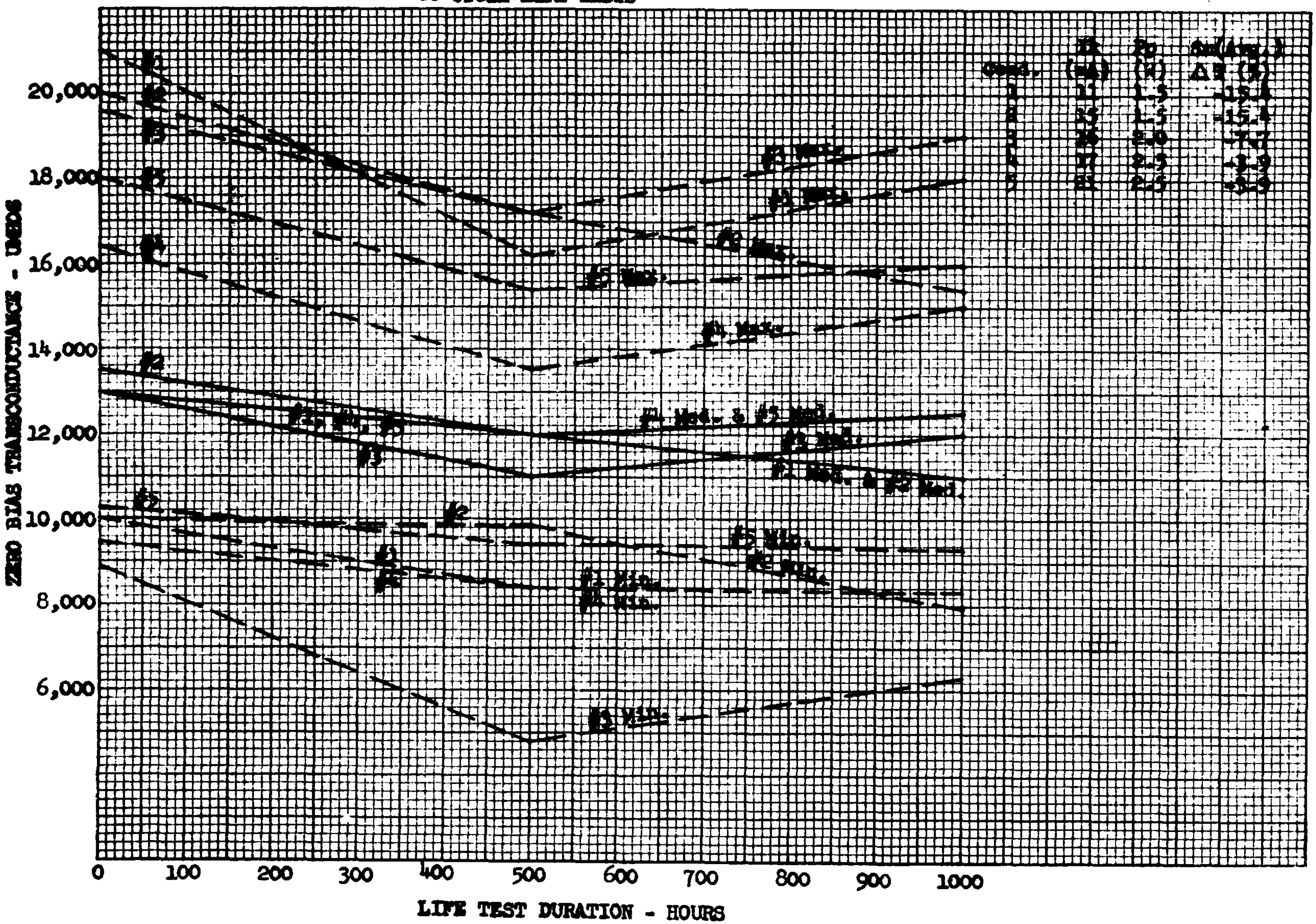

Figure 1 - Page 5

for comparison with 60 cycle life.

The number of failures are listed in Table II.

	Inop.	If	O Sm	450 Mc Po Δt	5900 Mc Po_2	F Δt	Ihk	IR
LTEP		222-264	6500**	30%	3 mW 15 mW	50 Mc	20 uA	50 Meg
Cond. 1	0	0	0	0	1-15 mW	0	0	0
Cond. 2	1	0	0	0	1-3 mW 1-15 mW	0	0	0
Cond. 3	0	0	0	0	1-15 mW	0	0	0
Cond. 4	1	0	0	0	0	0	0	0
Cond. 5	2	0	0	0	2-3 mW 3-15 mW	1	0	0
Total	4*				3-3 mW 6-15 mW	1		

Table II Number of Defectives on Life Testing at 450 Mc

(10 Tubes Per Condition)

* Includes 2 which were physically damaged during final testing period.

** Limit on 60 cycle life only.

3.2.2 - 60 CYCLE LIFE TEST

A 100 tube sample was tested at 60 cycles. Twenty tubes were subjected to each of five test conditions as reported last quarter (3.2.2, page 5). These conditions are repeated in Table III.

Condition	Ep (Volts rms)	Ik (ma)	Ig (ma)	Rg (Ohms)	Pw (Watts)
1	130	11	1.	6800	1.5
2	103	15	2.5	2200	1.5
3	130	16	2.3	2700	2.0
4	150	17	2.5	2700	2.5
5	130	21	3.5	1600	2.5

Table III 60 Cycle Life Test Conditions (eg = 14V)

A total of 13 of the 100 tubes failed for either grid to cathode shorts or grid-to-all insulation resistance. There were no failures for production life testing on Lot 62-17. A majority of these failures occurred during or following an off period for testing. Loose particles may account for some of these failures. It is also believed that the high failure rate might be caused by the grid drive. The source voltage of 14V RMS is fed through a series resistor, and the full voltage appeared between the grid and cathode during tube warmup each time the heater was cycled. The normal test condition uses 7.7V RMS which is fed through a large valued series capacitor to the grid. A resistor is connected between grid and cathode. The maximum voltage in this case is 7.7 volts.

Of 100 tubes in the 60 cycle life tests, 5 tubes exhibited a heater current above the established limit. It has been anticipated that the proposed heater design changes would reduce the amount of heater current climb. Preliminary tests on tubes with these changes are summarized later in this report (3.3.1, page 12).

Favorable effects of heater design changes are supported by 1000 hours of life testing.

There was one failure for low zero bias transconductance from 20 tubes operating under condition 3 (16 mA Ik), the other 4 lots had no failures. Condition 4 and 5 (17 and 21 mA cathode current respectively) were the most stable. Figure 2 illustrates these test results.

Power output at 450 Mc was read as a point for comparison with life test conditions for 450 Mc life. This is not a specified life test end point. The 60 cycle life test was performed at 5 conditions ranging from 10 mA to 17.5 mA of plate current. The acceptance inspection test condition for reading 450 Mc power output is now specified as 8 mA plate current. Eleven failures occurred from 100 tubes tested to this specification. Direct correlation on the basis of 450 Mc Po therefore is not possible between 450 Mc and 60 cycle life tests since readings for 450 Mc life were taken on the life test rack at the current level of the particular life test condition. Consideration will be given to establishing a uniform test condition throughout the specification.

The power output at 5900 Mc was observed although this also is not a life test end point on 60 cycle life. Six tubes from a total of 100 failed when testing to the 3 mW minimum as specified as an end point for 450 Mc life. Twenty tubes failed when testing to a 15 mW limit. The 13 mA plate current test condition appears to be marginal and it was decided that definite conclusions should

TYPE - 7486

450 MC LIFE TESTS

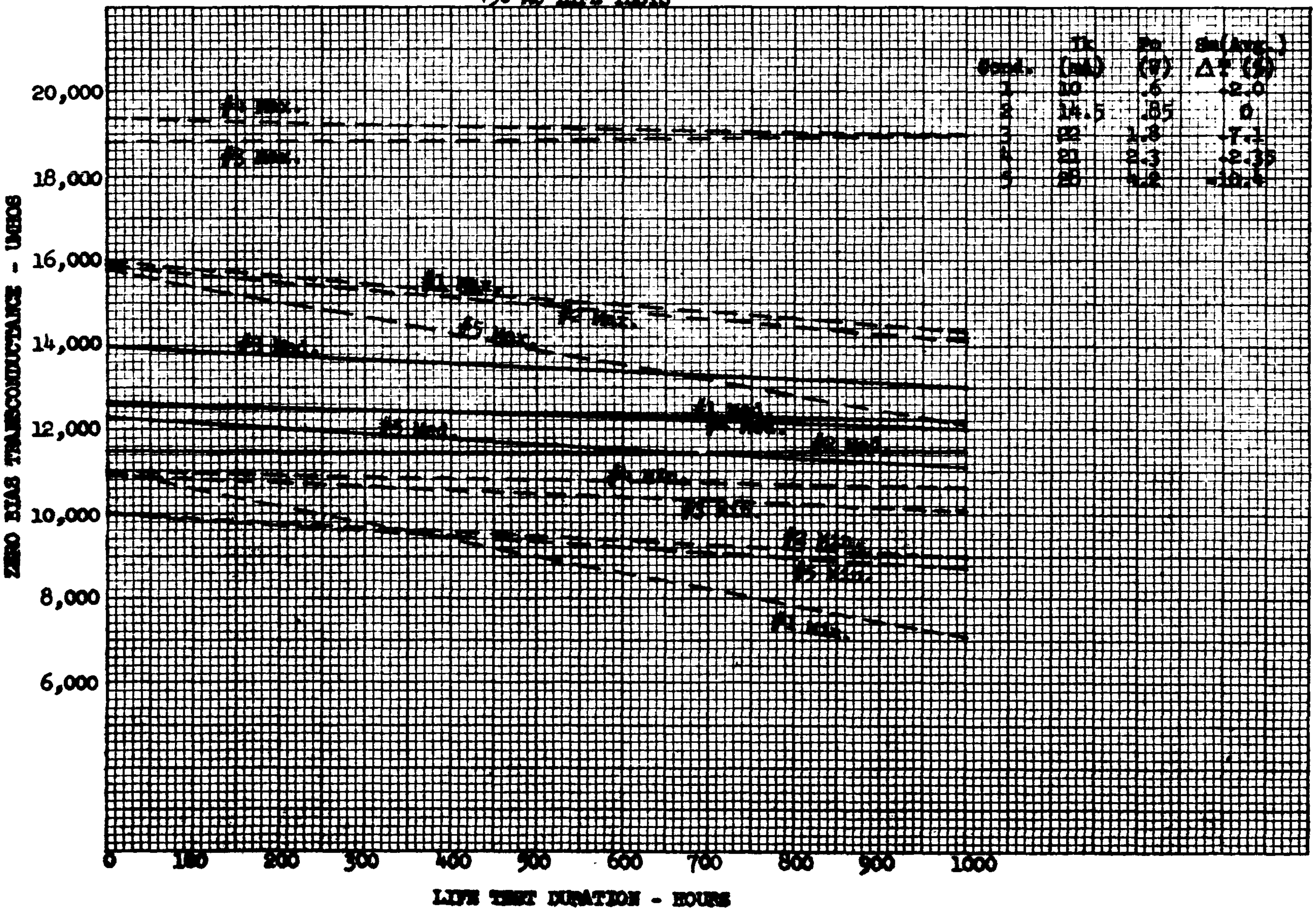

Figure 2 - Page 9

not be drawn from these data. Future testing for both 5900 Mc Po and 450 Mc Po is to be done at current ratings at which the life test is run.

A summary of the number of life test defectives at 60 cycle life is provided in Table IV.

	Inop.	If	OSm	Sm ΔEf		IR	450 Mc Po Δt	5900 Mc Po_2	F Δt
LTEP		222-264	6500	25%	20 ua	50 Meg	Info 30%	Info	Info
Cond. 1	2	0	0	2	0	4	1	1-3 mW 3-15 mW	0
Cond. 2	0	2	0	1	0	0	7	4-15 mW	0
Cond. 3	1	0	1	0	0	1	0	2-3 mW 5-15 mW	0
Cond. 4	2	2	0	0	0	1	0	1-3 mW 3-15 mW	0
Cond. 5	2	1	0	2	0	0	1	2-3 mW 5-15 mW	0
Total	7	5	1	5	0	6	11	6-3 mW 20-15 mW	0

Table IV Number of Defectives On Life Testing At 60 Cycles Per Second. (20 Tubes Per Condition)

3.2.3 - SELECTION OF LIFE TEST CONDITIONS

The life test data on production Lot 62-17 were reviewed at an internal meeting on March 26, 1963. The objective was to select from the five conditions, two conditions each of 450 Mc life and 60 cycle life for future testing aimed at improving the tube ratings.

It was pointed out that our proposed specification, SCL-7001/74, raises the cathode current rating from 10 mA to 15 mA. and the plate dissipation from 1.0 watts to 1.5 watts. It was agreed that, of the two conditions selected for future testing, one should reflect the tube ratings and one should be at a higher point at which the tube could reasonably be expected to pass. On this basis, the conditions which were selected are as follows in Table V.

60 Cycle Life

	Condition 1	Condition 2
Eb	180 Vdc	180 Vdc
Eg	6 V RMS	6 V RMS
Rl	3300 Ohms	2200 Ohms
Rg	1200 Ohms	700 Ohms
Ig	1.9 mA	2.9 mA
Ip	13.2 mA	17.1 mA
Ik	15.1 mA	20 mA
Pp	1.53 Watts	2.08 Watts

450 Mc Life

	Condition 1	Condition 2
Ep	150 Vdc	250 Vdc
Ig	5 mA	6 mA
Ik	15 mA	21 mA
P_{in}	1.5 Watts	3.75 Watts
P_{out}	0.85 Watts	2.3 Watts

Table V Life Test Conditions Selected For Future Testing

3.2.4 - 2200 MC POWER GAIN TEST SET

All construction on modification of the cavity for easier access has been completed. The test set is still in the Engineering Test Lab., but is to be transferred soon.

3.2.5 - ENGINEERING SAMPLES

The first lot of engineering samples has been shipped. These tubes represent the present product which has been tested on the new equipment.

3.3 TASK III - TUBE DESIGN IMPROVEMENT

3.3.1 - HEATER DESIGN

Tubes were made with four different heater configurations: a regular production-type tungsten-wire heater with white coating, a tungsten-wire heater with the surface of the insulation darkened with tungsten, a heater of tungsten-rhenium alloy wire with a white coating, and a tungsten-rhenium alloy wire with the surface of the insulation darkened with tungsten. The tubes were subjected to a series of four tests:

1. A progressive stress heater-cathode life in which the potential applied between heater and cathode is varied.
2. A heater cycling test in which the heater voltage is cycled on and off.
3. A 1000 hour, 60 cycle life test with a positive heater-cathode potential.
4. A 1000 hour, 60 cycle life test with a negative heater-cathode potential.

The progressive stress heater-cathode life test consists of varying the heater to cathode voltage from 140 Vdc to some voltage (usually 900 V) at which a breakdown will occur. The rate of voltage change is 16 volts per hour. The evaluation of design changes is based on the rate of failure for each design.

Each of the four designs tested were subjected to the maximum supply voltage of 1000 volts without 100% failure of the lot. The failure rates for the two darkened heaters were 17.7% for tungsten wire and 23.5% for tungsten-rhenium wire. The two white heaters exhibited 70.0% and 71.2% failure rates for tungsten wire and tungsten-rhenium wire respectively. A distinct advantage is indicated from the darkening process.

The heater cycling test consists of cycling the heater voltage. Heater voltage is on one minute and off one minute with a positive heater to cathode voltage of 70 volts. Measurements are made for shorts, opens, and heater-cathode leakage current. The only failures for leakage are to be reported for darkened heaters. Failures first appeared at 6000 cycles for tungsten-rhenium heaters and at 8000 cycles for tungsten heaters. There was one failure for an open heater in each lot of white heaters. Grid to cathode shorts occurred in all lots,but this appears to be due to loose particles. This would imply that heater design is not a factor. Internal inspection revealed a little more sublimation from dark heaters. Slightly more sublimation occurred from tungsten-rhenium wire heaters than from tungsten heaters.

The 60 cycle life test was performed with two conditions. A 70 volt dc potential was applied between heater and cathode. In one condition, E_{hk} was positive, and in the second, E_{hk} was negative. Heater current changes and heater-cathode leakage were noted.

In the lot tested with a positive E_{hk}, the most stable heater current was with darkened tungsten-rhenium wire. In most cases, the change was so little as to be within reading accuracy. The "white" heaters possessed the maximum variation with the greatest change in regular tungsten wire. No leakage failures were found on any lot in this test.

In the lot tested with negative E_{hk}, again the most stable heater current was with the darkened tungsten-rhenium wire. Here also the change was within reading accuracy. The lot with "white" tungsten heaters had 60% which exceeded the established upper limit for heater current. The failures can be attributed to a lot of heaters which possessed characteristics causing failure in our regular production. This test is being repeated with another lot of heater wire. One failure occurred within the lot of dark tungsten-rhenium wire for heater-cathode leakage current. No failures occurred in any other heater configuration.

Heater current climb during life is summarized in Table VI comparing these heater tests with other available data. It should be noted that the regular and the special 60 cycle life tests utilize a negative E_{hk}. The 450 Mc life test has no potential applied be-

Test	Average Change In Heater Current	Number Tubes Above 264 mA (0-1000 Hrs.)	Total Tubes
Regular 60 Cycle Life (Lot 62-17)	+ 16.07 mA	2	15
Pulse Life (Lot 62-17)	+ 12.67 mA	0	15
Special 60 Cycle Life (From Lot 62-17) (-Ehk)			
Condition 1	+ 13.22 mA	0	20
Condition 2	+ 15.25 mA	2	20
Condition 3	+ 13.89 mA	0	20
Condition 4	+ 14.67 mA	2	20
Condition 5	+ 16.58 mA	1	20
450 Mc Life (From Lot 62-17) (No Ehk)			
Condition 1	+ 10.8 mA	0	10
Condition 2	+ 9.0 mA	0	10
Condition 3	+ 8.7 mA	0	10
Condition 4	+ 9.4 mA	0	10
Condition 5	+ 11.3 mA	0	10
Heater Tests (+Ehk)			
Tungsten-Rhenium - Dark	- 1.5 mA	0	10
Tungsten-Rhenium - White	+ 7.4 mA	0	10
Tungsten - Dark	+ 6.3 mA	0	10
Tungsten - White	+ 10.1 mA	0	10
Heater Tests (-Ehk)			
Tungsten-Rhenium - Dark	+ 1.3 mA	0	10
Tungsten-Rhenium - White	+ 9.0 mA	0	10
Tungsten - Dark	+ 4.5 mA	0	10
Tungsten - White	+ 31.7 mA	6	10

Table VI Heater Current Climb During Life tween heater and cathode. These three tests contain tungsten heaters with white coating. A negative E_{hk} appears to accelerate heater current climb. Use of darkened tungsten-rhenium wire was effective to 1000 hours. Continued long life tests are operating.

Effects of the new material on emission properties were investigated. The use of these materials did not seem to cause any degradation or cathode poisoning in any form. Figures 3 and 4 illustrate this test.

3.3.2 - CATHODE SPRAY MASK DESIGN

Life tests have been completed for evaluation of new cathode spray mask designs. The selection of the final design was not based solely on electrical characteristics observed in these tests. The number of failures at various testing periods which could be attributed to loose particles of cathode coating was one factor. The ease of fabrication of the final design fixtures was another. Table VII and Figures 5, 6, and 7 present a summary of transconductance and plate current effects.

All lots experienced an early life degradation in both zero bias transconductance and plate current. Tests have been performed on tubes stabilized under high current density conditions in order to eliminate this effect. Successful operation to 150 hours can be reported with no degradation. A control group tested similarly but with the original stabilization experienced degradation and eventual recovery in all tubes. Due to this degradation, a parallel series of life tests is planned for tubes containing design

EFFECTS OF HEATER DESIGN CHANGES ON TRANSCONDUCTANCE

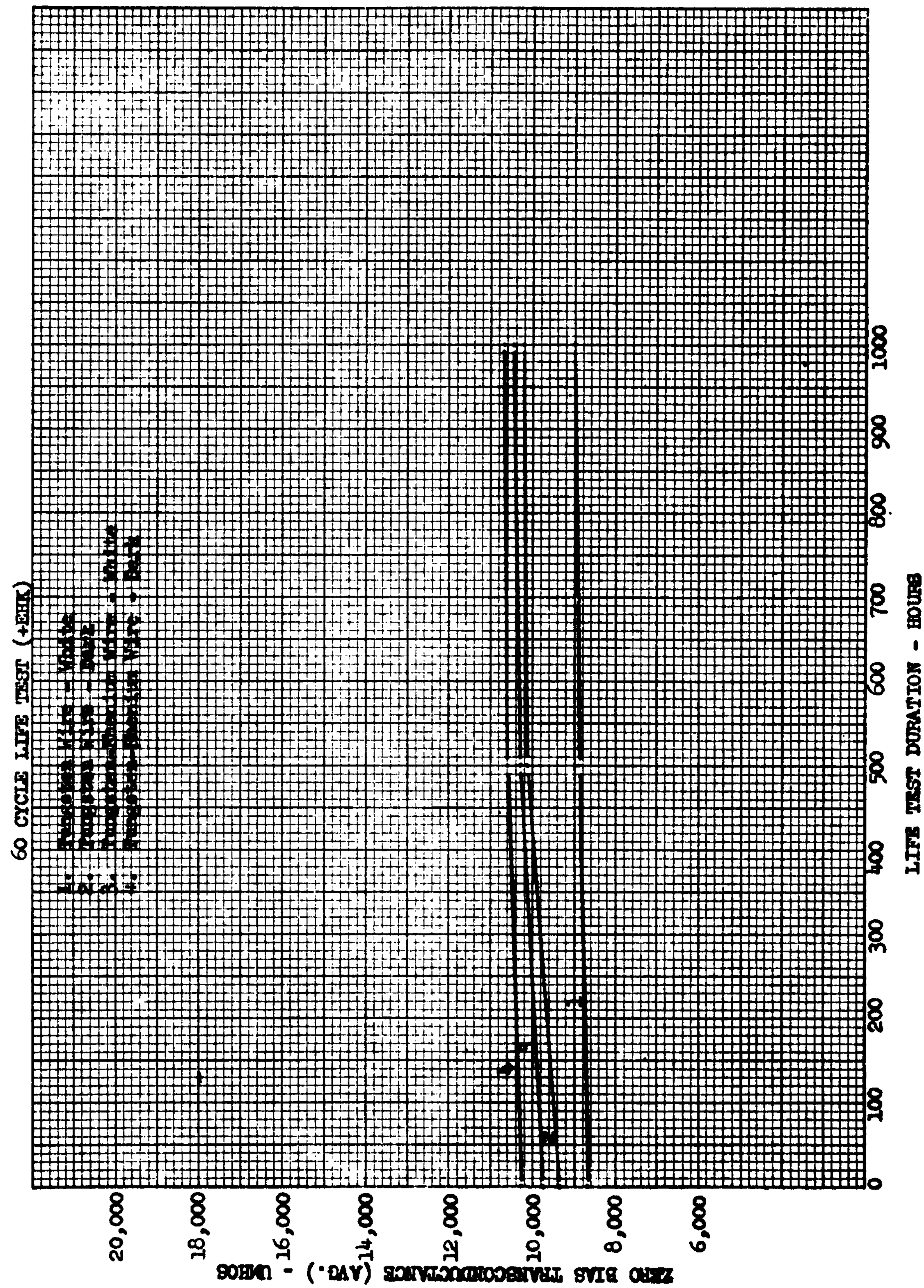

Figure 3 - Page 17

ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC

EFFECTS OF HEATER DESIGN CHANGES ON TRANSCONDUCTANCE

60 CYCLE LIFE TEST (-EHK)

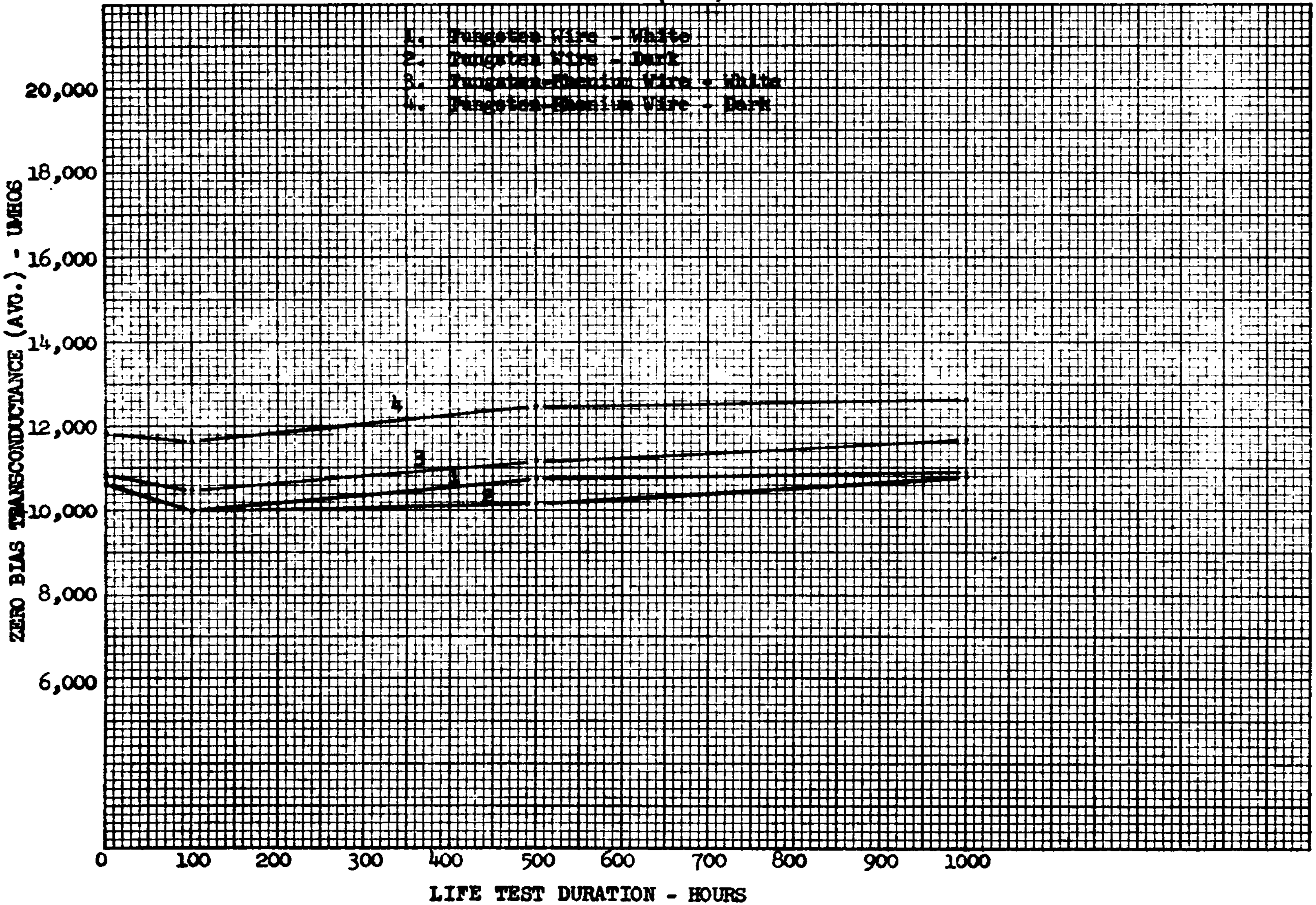

Figure 4 - Page 18

	0 Hours		500 Hours		1000 Hours	
	0 Sm	Ip	0 Sm	Ip	0 Sm	Ip
60 Cycle Room Temp.						
Beveled Mask	12,228	7.28	11,336	6.93	11,700	7.48
Lipped Mask	10,128	6.84	9,914	6.7	9,812	7.20
Regular Mask (50#)	12,860	6.88	12,060	6.36	13,000	7.18
Regular Mask (40#)	14,420	7.54	12,860	6.54	13,040	7.02
Pulse Life						
Beveled Mask	11,052	6.88	9,028	6.00	10,292	6.48
Lipped Mask	12,868	7.96	11,202	6.88	11,480	7.76
Regular Mask (50#)	13,060	7.34	11,054	5.84	11,100	6.08
Regular Mask (40#)	13,544	7.40	11,704	6.24	11,360	7.24
High Ambient Life.						
Beveled Mask	9,906	6.15	9,229	6.23	8,250	6.06
Lipped Mask	9,487	6.27	8,382	6.0	8,458	6.2
Regular Mask (50#)	11,020	6.66	9,832	6.26	9,751	6.21
Regular Mask (40#)	11,243	6.76	9,516	6.17	9,871	6.37

Table VII Zero Bias Transconductance and Plate Current From Life Tests On Cathode Spray Mask Effects

60 CYCLE LIFE - ROOM TEMPERATURE

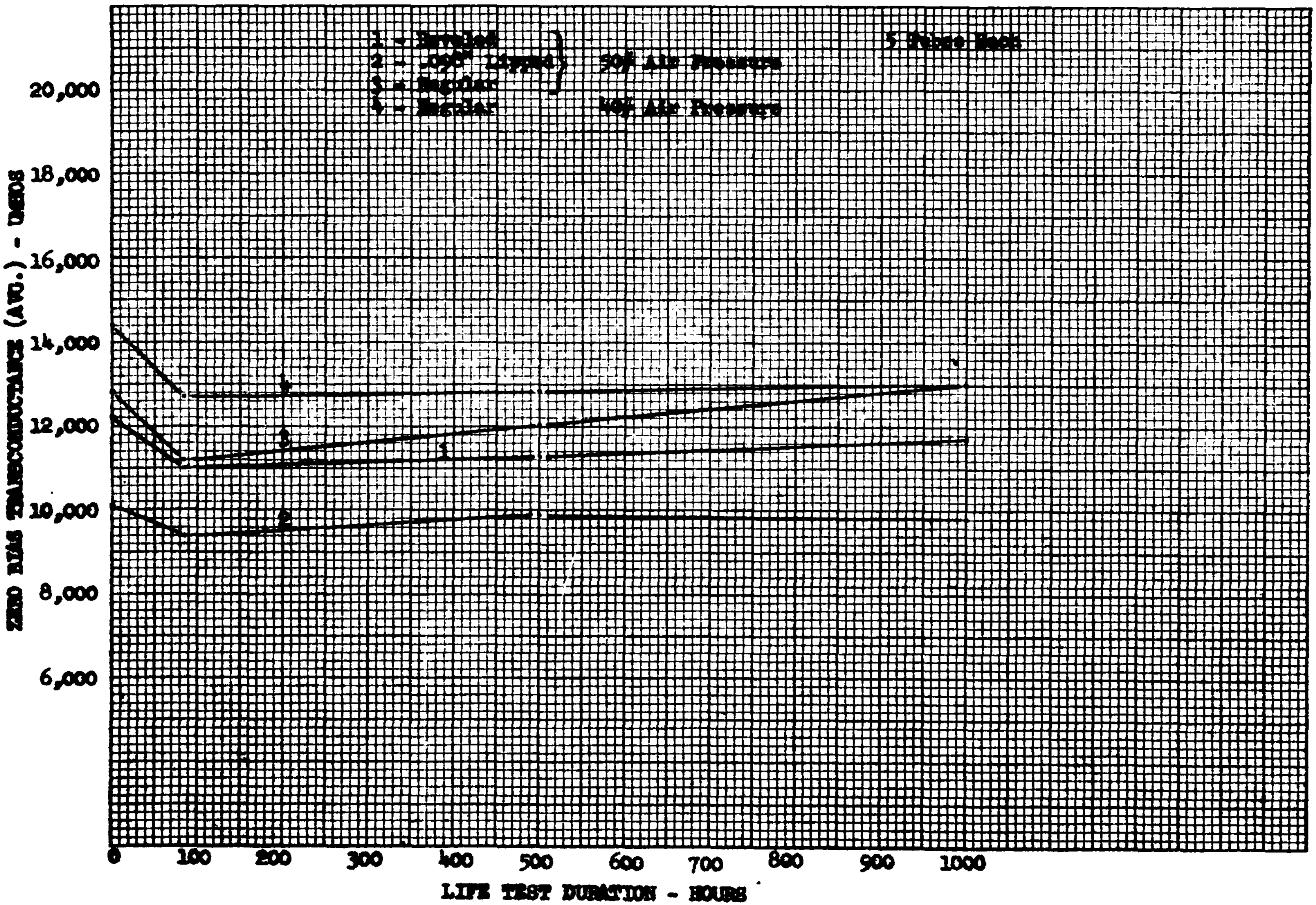

Figure 5 - Page 20

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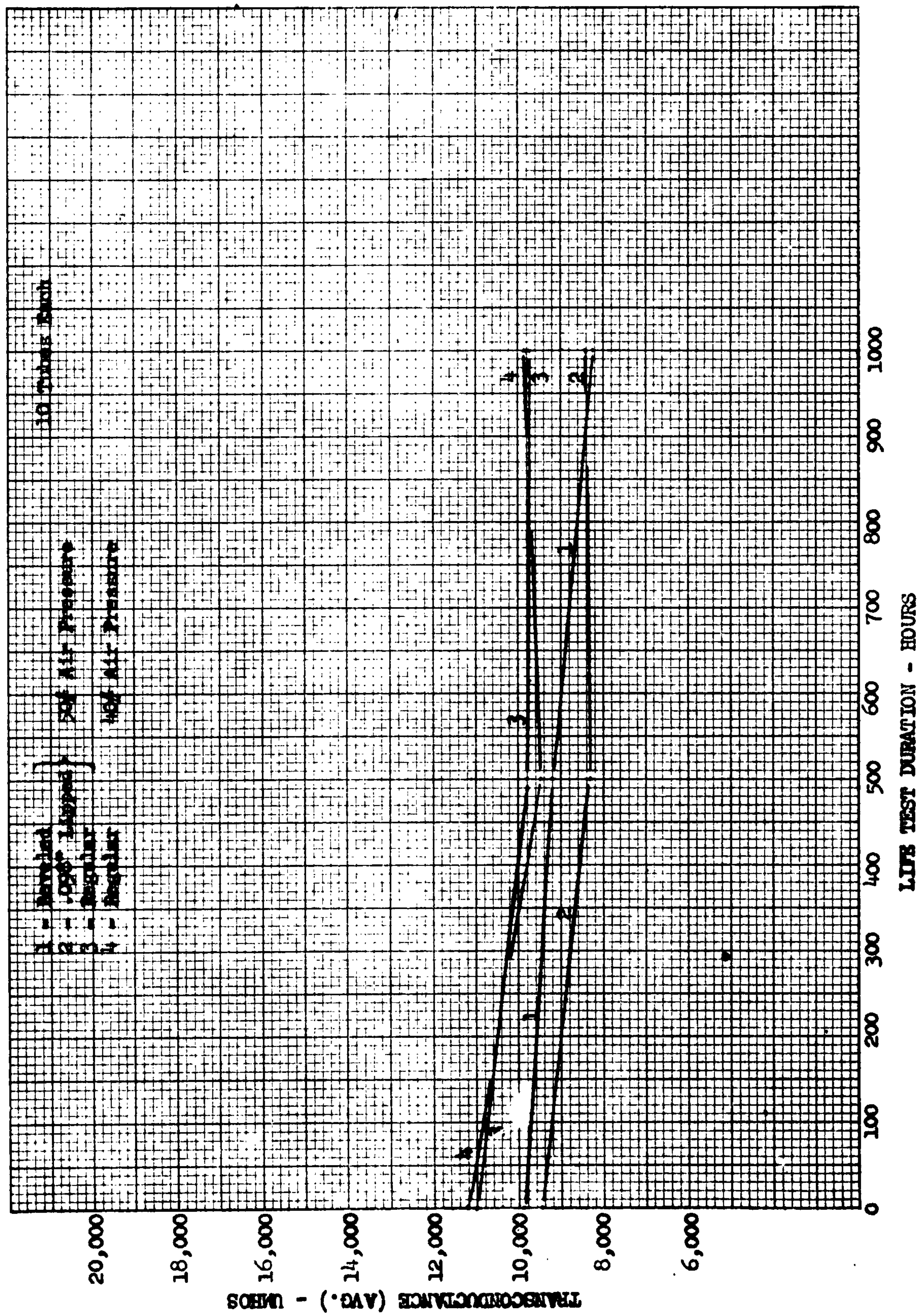

Figure 6 - Page 21

ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC

PULSE LIFE - ROOM TEMPERATURE

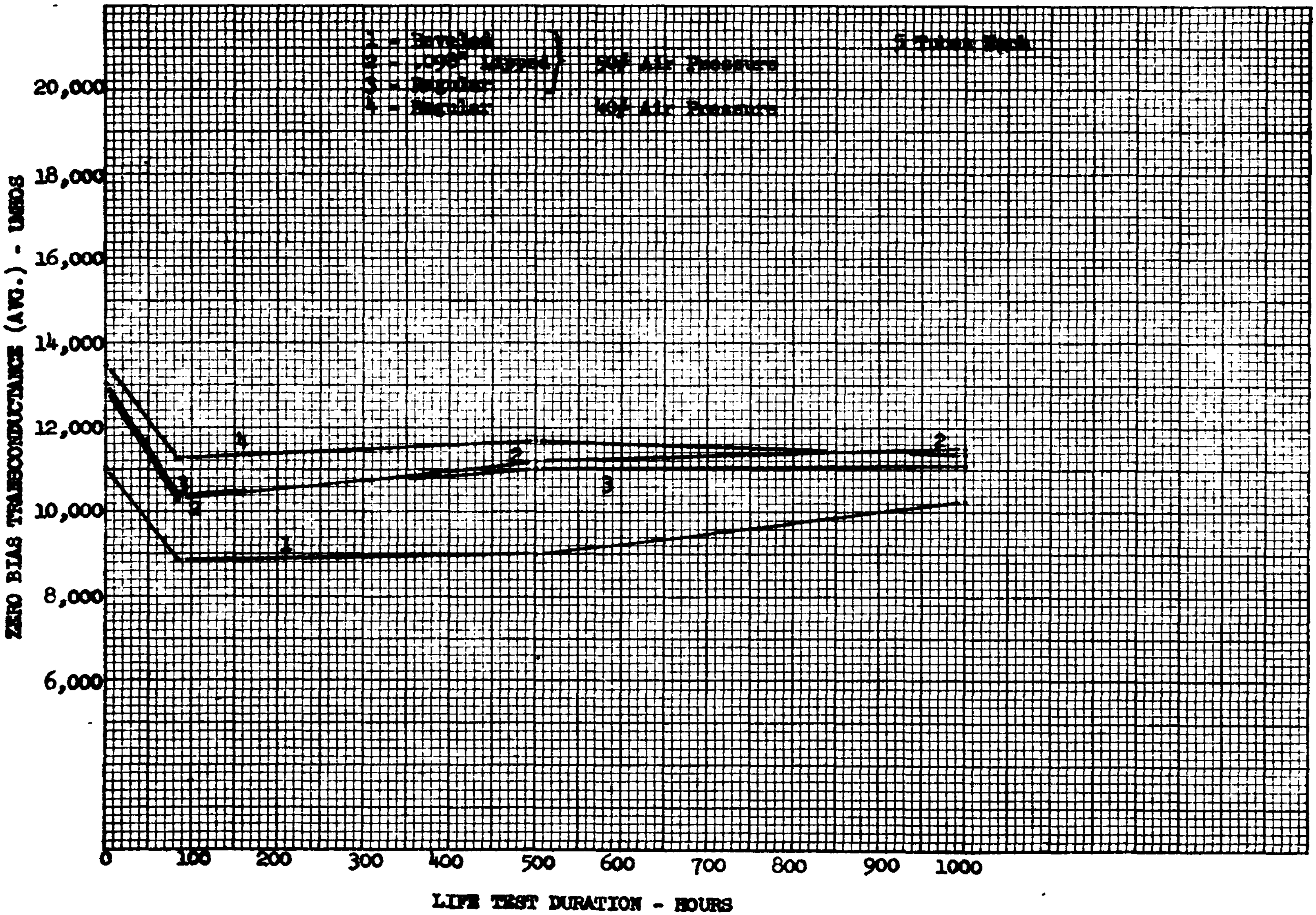

Figure 7 - Page 22

changes with both stabilization procedures to be used.

Failures which were attributed to particles amounted to 10% of the total tubes made with the regular spray mask on the initial run. In parallel tests, the tubes made with the lipped mask had no failures and the lot made with the beveled mask had two failures. Internal inspection could not detect the cause as being due to particles. Another lot of 300 tubes made with the beveled mask exhibited 3 similar failures the cause of which was not detected.

Both new designs provided the required reduction in rejects due to stray particles of cathode coating. A complete set of beveled masks was ordered. Since they were more easily produced, the set was ready for use within two weeks. The lipped mask was not entirely eliminated from consideration. It may be recalled at a later date.

4.0 CONCLUSIONS

The vacuum system has not been received. Life tests on the present product have been completed and the first lot of engineering samples has been delivered. Preliminary evaluation has been completed on tubes containing heater design changes and on tubes made using new cathode spray masks. Compatability of these design changes must still be verified. Final design spray fixtures have been completed. Production of tubes containing design changes has been started. Life tests are to begin as soon as stabilization is complete.

5.0 PROGRAM FOR THE NEXT INTERVAL

The vacuum system will be installed at the site of final operation. Prove out will be done at this location. Construction of tubes containing design changes will be completed. They will be evaluated on the new test equipment, and a second set of engineering samples will be set aside for later shipment. Effort will begin toward establishing processing schedules for the new exhaust equipment.

5.1 PROGRESS CHART - 7486 PEM
DA.36-039-SC-86738

	1962						1963												1964					
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
TASK I - VACUUM EXHAUST EQUIPMENT CONSTRUCTION																								
A. Design	(X)	(X)	(X)	(X)	⊗																			
B. Procure						(X)	(X)	(X)	(X)															
C. Prove Out										X	X													
D. Install												X												
TASK II - TEST EQUIPMENT																								
A. 450 Mc Life																								
1. Design	(X)	(X)	⊗																					
2. Construct				(X)	⊗																			
B. 60 Cycle Life																								
1. Design			(X)	(X)																				
2. Construct					⊗																			
C. 450 Mc Po Test																								
1. Design				(X)	⊗																			
2. Construct						⊗																		
D. 5900 Mc Po Test																								
1. Design			(X)	(X)	⊗																			
2. Construct					(X)	⊗																		
E. 2200 Mc Power Gain																								
1. Design		(X)	(X)	(X)	( )	( )	○																	
2. Construct					(X)	(X)	(X)	(X)	⊗															
F. Engineering Samples																								
1. Fabricate Tubes				(X)	⊗																			
2. Evaluate on Above Equipment						(X)	⊗	⊗																

X - Anticipated Progress
( ) - Actual Progress
○ - Completed

5.1 PROGRESS CHART - 7486 PEM
DA.36-039-SC-86738

	1962						1963												1964					
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
TASK III - TUBE DESIGN IMPROVEMENT																								
A. Heater																								
1. Establish Alternative Designs	(X)	X																						
2. Procure Coils		(X)	(X)	(X)	( )	O																		
3. Construct Tubes With Different Coil Designs				X	(X)	(X)	(X)	( )	O															
4. Set Up Heater-Cathode Life Equipment	(X)	X																						
5. Life Test & Evaluate				X	(X)	(X)	(X)	(X)	O															
B. Cathode Coating Techniques																								
1. Design Experimental Spray Masks - Make Models			(X)	(X)	(X)	(X)																		
2. Build Final Design Spray Fixtures							(X)	(X)																
3. Life Test Experimental Samples				(X)	(X)	(X)	(X)	(X)	O															
C. Engineering Samples																								
1. Make Tubes Incorporating Design Improvements									(X)	X	X	X												
2. Evaluate on Improved Test Equipment													X											
3. Deliver Samples																								
TASK IV - EVALUATION OF EXHAUST EQUIPMENT																								
A. Establish Processing Schedules												X	X	X										
B. Process Tubes on Comparative Vacuum Equipment																X								
C. Test Tubes & Evaluate Vacuum Equipment																	X	X						

X - Anticipated Progress
() - Actual Progress
O - Completed

5.1 PROGRESS CHART - 7486 PEM
DA.36-039-SC-86738

	1962						1963												1964					
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
TASK V - PERFORM PRE-PRODUCTION RUN																								
A. Fabricate Pre-Production Samples														X	X									
B. Perform Pre-Production In-Plant Testing															X	X	X							
C. Prepare Test Reports & Other Technical Data Required																X	X							
D. Prepare Inspection & Quality Control Plan																X	X							
TASK VI - PERFORM PRODUCTION RUN																								
A. Fabricate Tubes on Pilot Production Facilities																				X				
B. Test to Applicable Specification																				X	X	X		
TASK VII - CONSTRUCT ADDITIONAL LIFE TEST EQUIPMENT																						X		
OTHER REQUIREMENTS																								
A. Draft Final Report																							X	
B. Prepare Bill of Materials																							X	

X - Anticipated Progress
8 - Actual Progress
O - Completed

6.0 PUBLICATIONS, REPORTS AND CONFERENCES

6.1 PUBLICATIONS - None

6.2 REPORTS

- Monthly Report No. 7
  PEM For Tube Type 7486
  by J. D. Marshall for the period of
  January 1, 1963 to February 1, 1963

- Monthly Report No. 8
  PEM For Tube Type 7486
  by J. D. Marshall for the period of
  February 1, 1963 to March 1, 1963

- Monthly Report No. 9
  PEM For Tube Type 7486
  by J. D. Marshall for the period of
  March 1, 1963 to March 31, 1963

- Quarterly Report No. 2
  PEM For Tube Type 7486
  by J. D. Marshall for the period of
  1 October 1962 through 31 December 1962

6.3 CONFERENCES

1. Organizations and personnel present:

   USASSA
   L. Coblentz

   General Electric Company
   J. D. Campbell
   E. L. Davis
   J. D. Marshall
   H. L. Thorson

   Place and date:
   General Electric Company
   Owensboro, Kentucky

   January 16, 1963

   Subject:
   To review progress to date and discuss future schedule.

7.0 PERSONNEL

Engineering personnel qualifications not included in previous reports are described on the following pages. Time spent on the program during this report period was as follows:

J. D. Campbell	129 hours
J. D. Marshall	168 hours
S. A. Jolly	127 hours
R. E. Pitts	115 hours
H. W. Grant	108 hours
C. H. Howard	48 hours
L. F. Jeffrey	44 hours
W. U. Shipley	40 hours
V. P. Quirk	34 hours
J. R. Osborne	12 hours
D. A. Noblett	10 hours
G. E. Moore	6 hours
Other personnel	4 hours

Submitted by:

J. D. Marshall

J. D. Marshall
Planar Tube Product Design
Receiving Tube Department

Approved by:

J. D. Campbell

J. D. Campbell, Project Engineer
Planar Tube Product Design
Receiving Tube Department

DR. C. H. HOWARD - CRYSTALLOGRAPHER, BIOCHEMIST - ADVANCED DEVELOPMENT

Dr. Howard received his Bachelor of Arts Degree in Science from Baker University in 1931, his Master of Science Degree in Biochemistry from Oklahoma A & M College in 1933, and his Ph.D. in Biochemistry from Rutgers University in 1935. He worked with E. R. Squibb and Sons and the Kendall Chemical Company as a chemist from 1935 to 1949. Dr. Howard transferred to the Receiving Tube Department of General Electric from another component of the Company and has been assigned X-Ray Diffraction and Tube Materials Processing. He is a member of the American Crystallographic Association and the Society for Applied Spectroscopy.

MR. DAVID NOBLETT - SPECTROGRAPHER - ADVANCED DEVELOPMENT

Mr. Noblett graduated from Kentucky Wesleyan College in 1956 with a B.S. in Chemistry. He worked for Mead Johnson, Evansville, Indiana, as a chemist for six months in 1956. He attended Boston College in 1960 for a course in Industrial Spectroscopy. For the last six years he has been a spectrographer for the Receiving Tube Department of General Electric. He is a member of the Society for Applied Spectroscopy.

MR. V. P. QUIRK - METALLURGIST - ADVANCED DEVELOPMENT

After discharge from the Navy, he studied engineering at Virginia Polytechnic Institute, Blackburg, Virginia. In 1949, he received a B.S. in Ceramics and Metallurgy.

He joined the U.S. Steel Corporation in 1950, as a Ceramist in refractory evaluation. From 1951 to 1953, he served as an instructor of mineral technology for the Mineral Industries Extension Services, Pennsylvania State College, State College, Pennsylvania, while doing graduate work in Mineral Economics.

From 1953 to 1957, he did applied research and development in materials and processes for electron tubes at the General Electric Receiving Tube Department, Owensboro, Kentucky.

In 1957, he joined Westinghouse Electric Company, Bettes Atomic Power Department, as a Senior Engineer in design and development of nuclear core components.

He rejoined the General Electric Company in 1958, and since that time has been a Metallurgist in development and evaluation of materials for electronic tubes and tube circuit applications.

He is a Registered Professional Engineer in Kentucky, a member of the American Ceramic Society and American Society for Metals. He has done development work on vapor deposition of tungsten film on ceramic substrates for TDM Resistors.

MR. W. U. SHIPLEY - CONSULTING ENGINEER - ENGINEERING TEST LABORATORY

Mr. Shipley received his BSEE at Purdue University in 1949. Following graduation he entered the General Electric training program and in 1950 he became associated with the Engineering Test Laboratory, where, at the present he holds the position of Consulting Engineer.

Mr. Shipley has a broad experience in developing test methods and test equipment. He developed the "Shipley Interface Test Method" for measuring interface resistance in vacuum tubes.

He presented a paper at the IRE on "A Method of Measuring Cathode Interface Impedance" in 1956, and "The Effects of Pulse Operation" also at IRE in 1956. "An Impulse Test for Evaluating the Vibrational Characteristics of Receiving Tubes Over a Wide Frequency Range" was presented at IRE in 1958.

Mr. Shipley is a Senior member of IRE; A Registered Professional Engineer in Kentucky; The Chairman of JETC 5.8; and a member of Tau Beta Pi engineering society.

Mr. Shipley served as a navigator in the U.S. Air Force during World War II from 1942 until 1945 in the European Theatre of Operation.

GENERAL ELECTRIC COMPANY
ELECTRONICS COMPONENTS DIVISION
RECEIVING TUBE DEPARTMENT
OWENSBORO, KENTUCKY

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